Questions

1. If you took a bathroom scale into an elevator, would you weigh more or weigh less when the elevator accelerated upward? How about when the elevator accelerated downward? Please explain your answer.

   You would weigh more when the elevator accelerated upward, and you would weigh less when the elevator accelerated downward. This is a result of Newton's third law. Newton's third law states that forces come in pairs that are equal in magnitude but opposite in direction. When you are accelerating upward, there is a net force that is acting on you. As a result, you will exert a force of equal magnitude on the scale. This will cause the scale to give you a weight larger than what you would see when you are not being accelerated upward. The same argument is made for when you are accelerated downward.

2. Tom steps on a bathroom scale and weighs himself to be 150 lbs. He wants to weigh himself in an elevator that accelerates upward at 3.125 m/s^2. The elevator also accelerates downward at the same rate. Using the equation below, calculate what Tom's maximum weight and minimum weight would be in the elevator.

$$W_{\text{moving}} = W_{\text{stationary}} \pm \frac{3.125\ \text{m/s}^2}{9.81\ \text{m/s}^2} W_{\text{stationary}}$$

$$\begin{array}{|l|}\hline W_{\text{accelerated upward}} = 150\ \text{lbs} + \dfrac{3.125\ \text{m/s}^2}{9.81\ \text{m/s}^2}\left(150\ \text{lbs}\right) \approx 198\ \text{lbs} \\ \hline W_{\text{accelerated downward}} = 150\ \text{lbs} - \dfrac{3.125\ \text{m/s}^2}{9.81\ \text{m/s}^2}\left(150\ \text{lbs}\right) \approx 102\ \text{lbs} \\ \hline \end{array}$$

3. Does your plot look like an inverse square law plot? Why or why not?

   Actually, the plot looks like an inverse cube law plot. We used magnets in this experiment. The magnetic force obeys an inverse cube law. The gravitational force obeys an inverse square law.

4. Suppose that the skin between your thumb and index finger is 0.75 cm thick. If a pair of magnets were to pinch this piece of skin, how much force would be exerted? (Hint: Find 0.75 cm on the graph. Then find the force that corresponds to 0.75 cm.)

You need data to complete this question, but once you have the data, this question is easy to answer. Just follow the directions!

5. The sun has a diameter of approximately 870,000 miles. By how much would the gravity at its surface increase if it were to shrink down, while maintaining its mass, to approximately the size of Earth, which has a diameter of 8,700 miles. You must show work for full credit. (Hint: Newton's law of universal gravitation is an inverse square law.)

   We're going to take a ratio of the forces to see how it changes. The work below shows that the force due to gravity will be 10,000 times larger.

$$F \propto \frac{1}{r^2}$$

$$\frac{F_{8{,}700\text{ miles}}}{F_{870{,}000\text{ miles}}} = \frac{\dfrac{1}{\left(\frac{8{,}700\text{ mi}}{2}\right)^2}}{\dfrac{1}{\left(\frac{870{,}000\text{ mi}}{2}\right)^2}}$$

$$\boxed{\frac{F_{8{,}700\text{ miles}}}{F_{870{,}000\text{ miles}}} = 10,000}$$